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"The Chromosphere of VV Cephei"
and
"The Distribution of Circumstellar Dust Around Red Giants and Supergiants"

Final Report

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OF VV CEPHEI AND THE DISTRIBUTION
OF CIRCUMSTELLAR DUST AROUND RED
GIANTS AND SUPERGIANTS Final
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I. "The Chromosphere of VV Cephei"

The work on this project funded by this grant has already been described in previous status reports. The results were published in the Astronomy and Astrophysics Supplement Series. The full reference is:

Bauer, W. H., Stencel, R. E. and Neff, D. H. 1991, Astr. Ap. Suppl. Ser., 90, 175-190.

The examination of the archival spectra revealed significant changes in the spectra (particularly in additional absorption components shading most absorption features). Therefore, we obtained additional observing time with IUE to monitor the system during the summer of 1991. Short-term changes (over times less than two weeks in this binary with a 20-year period!) continue to be seen in both the overall spectrum and individual line profiles. Work continues on this object.

II. "The Distribution of Circumstellar Dust Around Red Giants and Supergiants"

A number of cool evolved stars are surrounded by dust shells of sufficient angular size as to appear extended in the IRAS survey data. The aim of this project has been to convolve the predictions of the flux distribution from model dust shells with the IRAS beam profiles in order to reproduce the observed IRAS scans. At the time of the last status report, the cross-scan profiles of the IRAS detectors had just been added to the modelling procedure. For scans in which the star passed near the detector center, there was no significant variation in predicted scan profile for different detectors. Scans in which the detector did not pass over the bright central star had been anticipated to be particularly useful in determining the dust distribution; however, significant differences in the predicted scan profiles were seen for different detector profiles. For this reason, and due to the cross-talk effects discussed in the previous status report, further work on the scans not including a central star has been postponed in favor of further analysis of scans passing over the central star.

In order to convert observed shell extent on the sky to a physical size, the distance to the star must be known. IRAS scans for a selection of Mira variables with distance estimates (Wyatt and Chan, 1983 Ap. J. 275, 225) and known to have silicate emission were examined to look for extension at 60 μm . Examination of the noise level and the smoothness of the background of the individual IRAS scans showed that peak fluxes greater than 20 Jy are needed in order for the faint extension to have sufficient signal-to-noise ratio for modelling purposes. Of eleven Miras which fit this criterion, symmetric extension was detected for five: o Cet, R Leo, R Cas, R Hor and U Ori.

Dust shell models with steady mass loss were made for a range of parameters appropriate for the sample and convolved with the IRAS detector profiles. The dependence of the various shell parameters on the observed extension was investigated, as shown in Figure 1. (ϕ represents stellar angular diameter, τ represents optical depth at 10 μm , R_{min} represents the inner radius of the dust shell in units of the stellar radius R_* , T_* represents the temperature of the central star, and T_{cond} represents the dust condensation temperature.

Dust shell models which fit both the IRAS Low Resolution Spectra and the IRAS point source fluxes were able to reproduce the observed extension for 4 of the 5 sources. The LRS spectrum of R Leo showed a very weak 10 μm excess, and the silicate grains used in the modelling could not explain the observed extension without showing a greater contrast in the 10 μm feature. Figure 2 presents some of the model fits. $W(10\%)$ represents the width of a scan at 10% of peak intensity. The single points with error bars represent the observations and the dashed and solid lines model fits.

Results were presented as a poster at the Seventh Cambridge Workshop on Cool Stars, Stellar Systems and the Sun, and will appear in the Proceedings of the Seventh Cambridge Workshop on Cool Stars, Stellar Systems and the Sun, eds. M. S. Giampapa and J. A. Bookbinder, to appear through the A. S. P. Conference Series. We are obtaining the Leung radiative transfer code for modelling dust shells, and will submit the Mira results to a refereed journal after running models with the new code.

Figure 1. DEPENDENCE OF EXTENSION ON STELLAR AND SHELL PARAMETERS

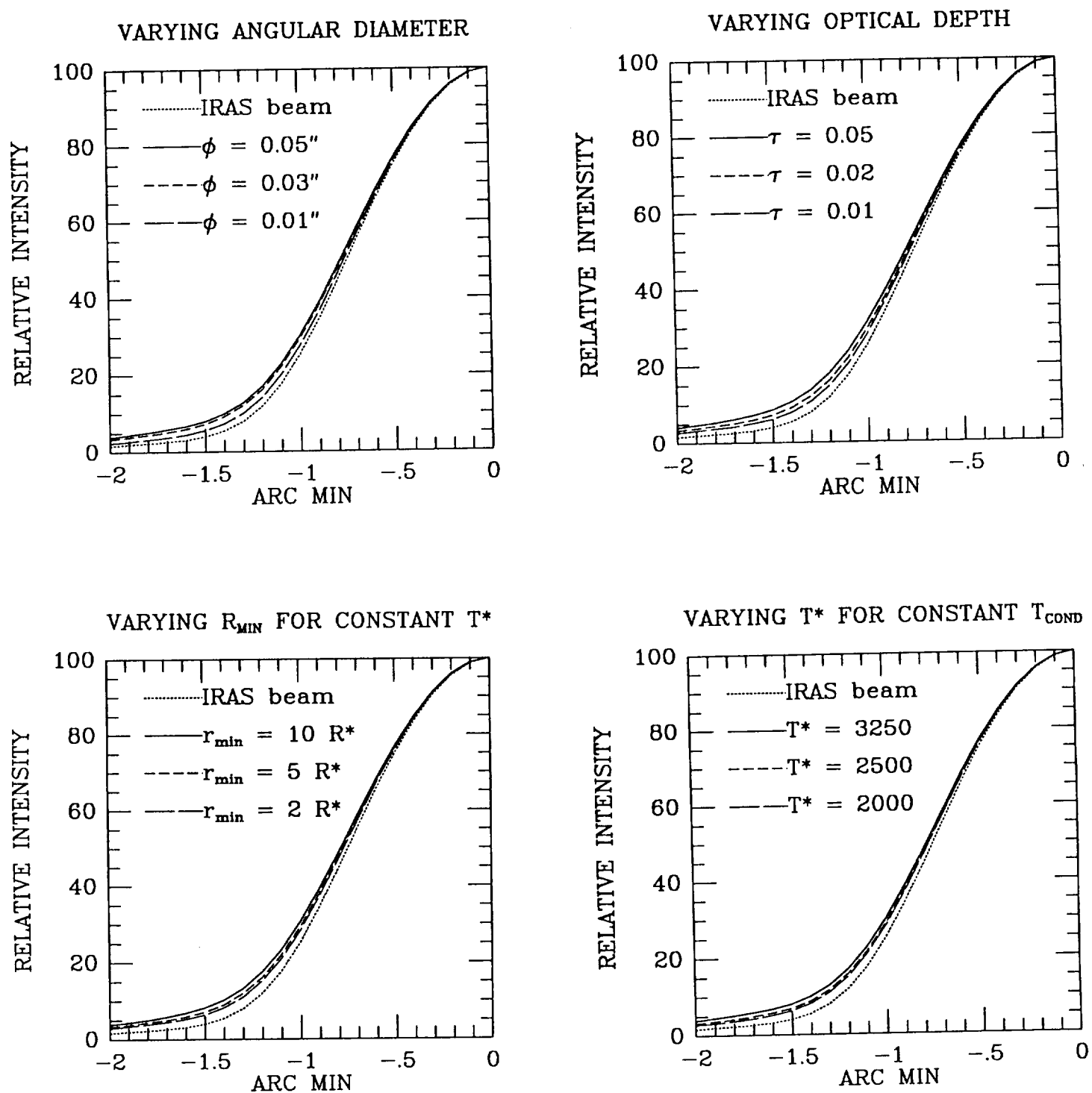


Figure 2. COMPARISON OF PREDICTED AND OBSERVED EXTENSION

